Viewing the Periodic Table of the Elements with X-rays

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The project we undertook was designed to help students understand atomic processes. We produced a total of 63 characteristic x-ray spectra of individual elements plus 12 spectra of "unknown" samples that students can analyze in order to determine their elemental compositions. These spectra have been placed on the web at http://ie.lbl.gov/xray. We hope that this will provide a useful visual aid for students and teachers to go along with the abstract concepts found in atomic science.

In order for us to fluoresce many different elements, we used an ^{241}Am source, which emits a 59.537 keV gamma ray. With this gamma ray we were able to fluoresce the K electrons of the elements ranging from Ca (atomic number, Z, = 20), whose K electron has a binding energy of 4.038 keV, to Tm (Z = 69), whose K electron has a binding energy of 59.390 keV. For elements with Z ranging from 70 (ytterbium) to 83 (bismuth), plus uranium and thorium, we were able to fluoresce only the L shell electrons.

To measure the x-rays emitted from each target, we used a planar germanium detector 1.3 cm thick and 3.6 cm in diameter sitting at a 90^{O} angle from the ^{241}Am source. We irradiated the sample with the 59.537 keV gamma rays, resulting in many of the fluoresced x-rays to be emitted towards the detector. We acquired the x-ray spectra in 512 channels using an ORTEC, PC based data acquisition system.

The energy spectrum shown in Figure 1 of germanium is a good example of one of our fluoresced elements. You can see two of the x-ray energy peaks caused by electron transitions to its K shell. The L x-rays of germanium are too low in energy to see in this spectrum. Figure 2 displays the x-ray spectrum of erbium, where you can see several high energy peaks caused by electron transitions to its K shell, as well as some low energy peaks caused by electron transitions to its L shell. We hope that this site will be a useful tool for students and teachers alike to become more familiar with atomic processes.

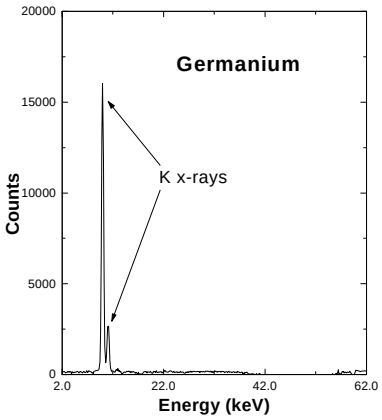

Fig. 1. An x-ray spectrum of germanium (Z = 32) showing its characteristic K x-ray energy peaks

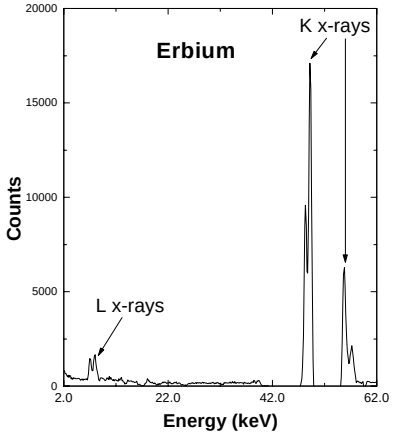

Fig. 2 An x-ray spectrum of erbium (Z = 68) showing both K and L x-rays.

Footnotes and References

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